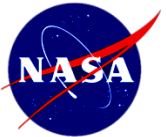


Motion Imagery and Robotics Application Project (MIRA)

8 October 2010



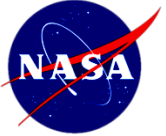
Background



- NASA Digital TV organization will deploy 3 cameras on the Exposed Facility (the “porch”) of the ISS JEM Module
- At request of CCSDS MIA WG (R. Grubbs) and SM&C WG
 - JSC Standards started investigating the use of CCSDS Mission Operations Spacecraft Monitor & Control
 - SM&C Conjecture – The SM&C SOA can provide a standards based methodology to control and status Robotic objects
 - CCSDS SM&C is a proposed integrated ground and space-based SOA
 - Specs are in various stages of CCSDS Red Book
 - Goal to mature MO SM&C SOA standards specs for Robotic Control
 - First time use of the SM&C standard
 - Develop Ops concepts for DTN + SM&C SOA
 - Cameras are a sub-class of Robotic Class of objects
 - Parameter, Action, and Alert services will be used to manage space-based Motion Imagery camera systems



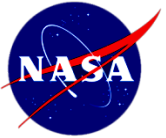
Background Continued



- SM&C is an application Service that can integrate many lower layer services to provide a consistent set of interfaces to mission development and Ops teams
 - Use AMS and DTN protocols
- Standardizing robotic operations leads to easier integration of various robot types and thus potentially lowers costs.
- An SM&C SOA approach provides capabilities for plug and play, software reuse, self identification, self configuration and discovery, and cross-agency policy based robot capability sharing
- Ops Concept Review
 - Identify architecture, of level of effort and cost, high level technical issues, etc. (Equal to NASA Mission Concept Review)

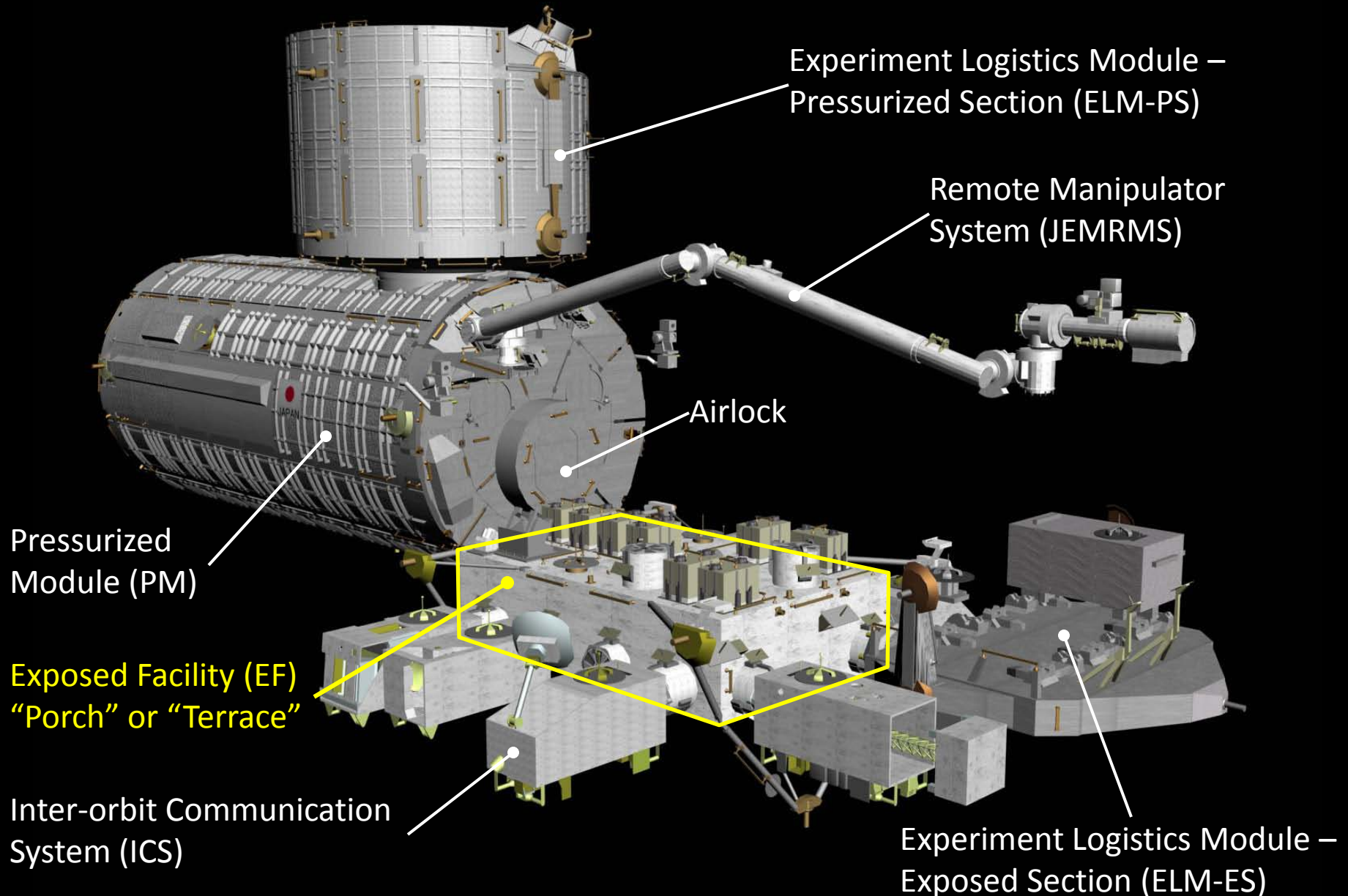


Contributors to Date



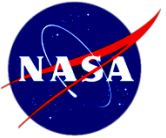
- Rodney Grubbs/Walter Lindblom – CCSDS MIA/NASA Digital TV
- JSC-OTF/L. Martinez/S. Lucord/Eric Wolfer/Eric Gallagher/T. Rich – Design and software implementation
- Robert L. Pitts, Mike Kearney, Kelvin Nichols – MSFC HOSC
- CU/K. Gifford - CU DTN project concepts
- Dave Wagner – JPL Mission Data System
- JSC Engineering – Laura Hood
- NASA CCSDS Standards Group

Japanese Experiments Module (JEM)“Kibo” Module

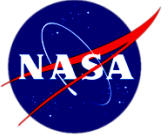




Key Operations Concepts



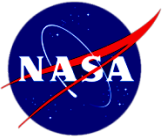
- Hi-definition cameras will be deployed, plug-n-play
- IP will be used to monitor video from the cameras
- IP and serial links will be used to control and monitor the cameras
- Pan/tilt/roll capability will be included
 - The P/T/R capability will be commandable via IP
 - The P/T/R unit may be integrated with a camera or a separate gimbal unit
- CCSDS standards will be used where possible (SM&C, DTN and others)
- SM&C MIRA services will manage interaction between the user and the camera within a Service Oriented Architecture
- CCSDS packets will carry IP traffic between ground and ISS
- Nodes at termination points will implement DTN protocols in order to demonstrate MIRA/SM&C/DTN
- Minimize flight crew impacts for installation, configuration and maintenance



MIRA Service



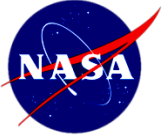
MIRA Service Concept



- MIRA Services
 - Control and monitor cameras
 - Control and Monitor of IP encoders
- Design the Services to be expandable to full robotic manipulation
- JSC Data Standards and MIRA are the technical authority for the implementation of the services



Camera Features and MIRA Services



Example Camera Features

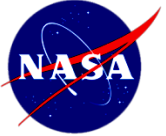
- Zoom lens
- Controllable Pan/Tilt/Roll unit
- Pan/Tilt/Zoom/Focus (P/T/Z/F) functions are single speed
- Camera has automatic and manual exposure capability
- Different preset color balance settings (i.e. Daylight, Tungsten) can be remote commanded
- Manual black balance capability
- Integrated lighting system
- Heating unit

Example Services

- Power control
- Heater control
- Pan/Tilt/Roll control
- Zoom control
- Toggle Auto / Manual Iris
- Iris control (when in manual)
- Perform Black Balance
- Perform Color Balance
- Recall Preset White Balance 1/2
- Recall Camera Setup 1...n
- Light control
- Upload preset file



Encoder Features and MIRA Services



Example Encoder Features

- Power On/Off
- Inputs Connections (BNC, etc.)
- Output Ports
- Encoding Algorithm
 - At minimum, supports H.264/AVC/MPEG-4 Part 10
- Data Bit Rate
- Frame Rate
- Chroma Subsampling
- Multiple Group Of Pictures (GOP) Settings
- IP-Assignable and Discoverable
- Browser-Based Management Console
- Load Pre-set Configuration
- Save Configuration
- Upload Configuration

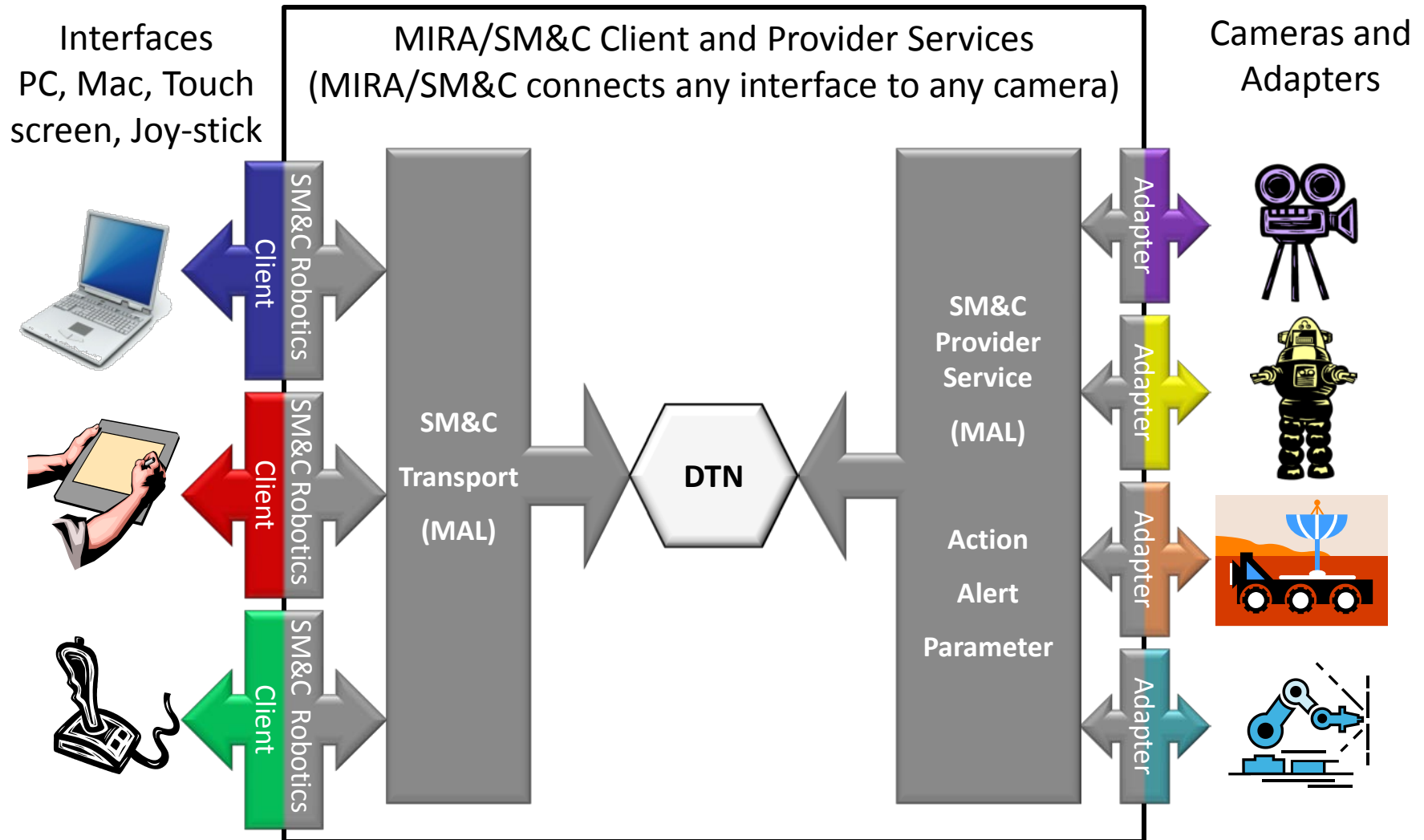
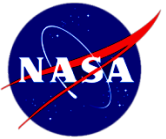
Example Services

- Power On/Off
- Select Algorithm
- Set Bit Rate
- Set Frame Rate
- Set Chroma Subsampling
- Set GOP
- Save Configuration
- Load Saved Configuration
- Upload Configuration

Software Architecture

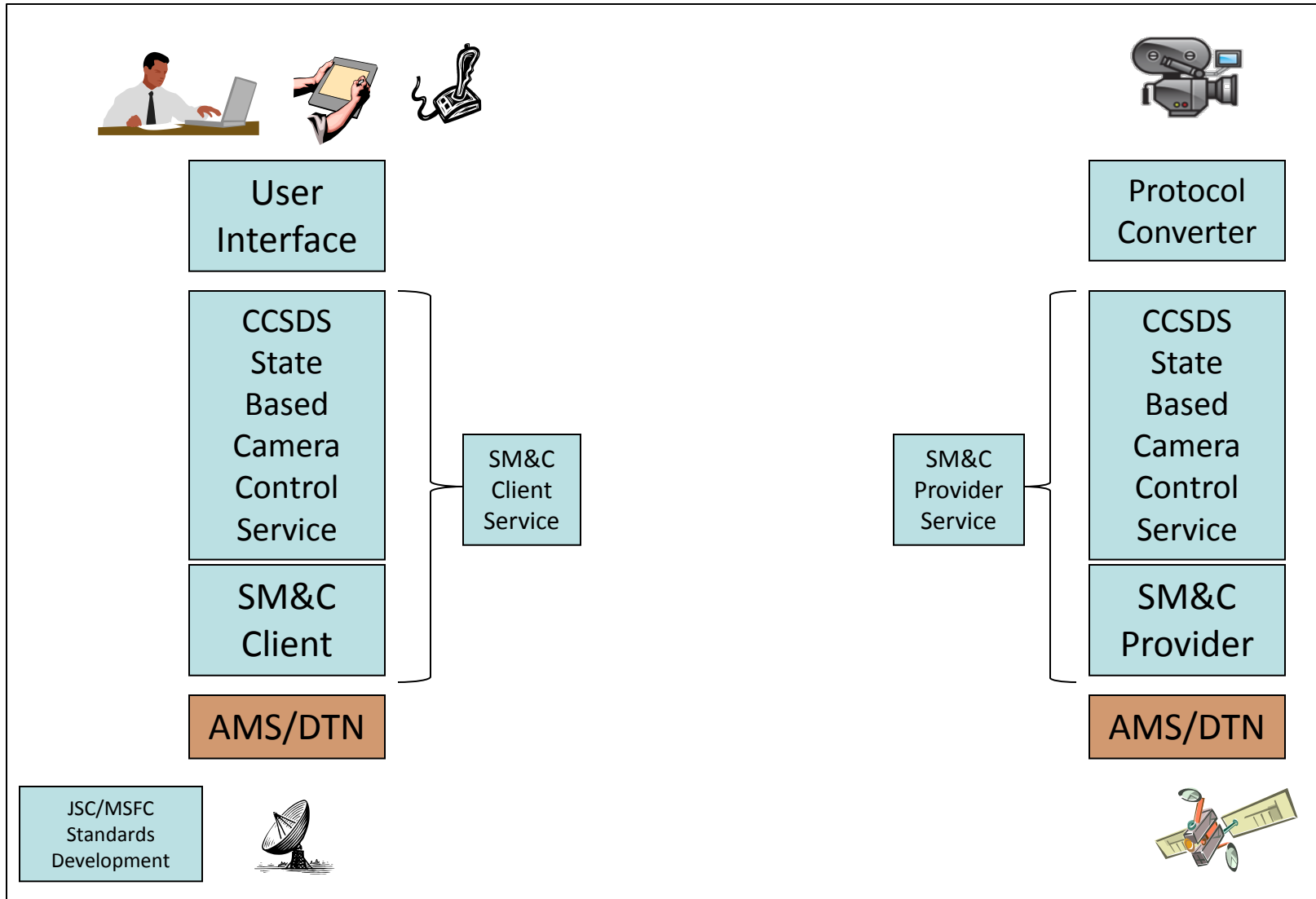
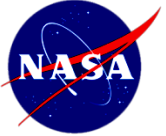


High Level Architecture



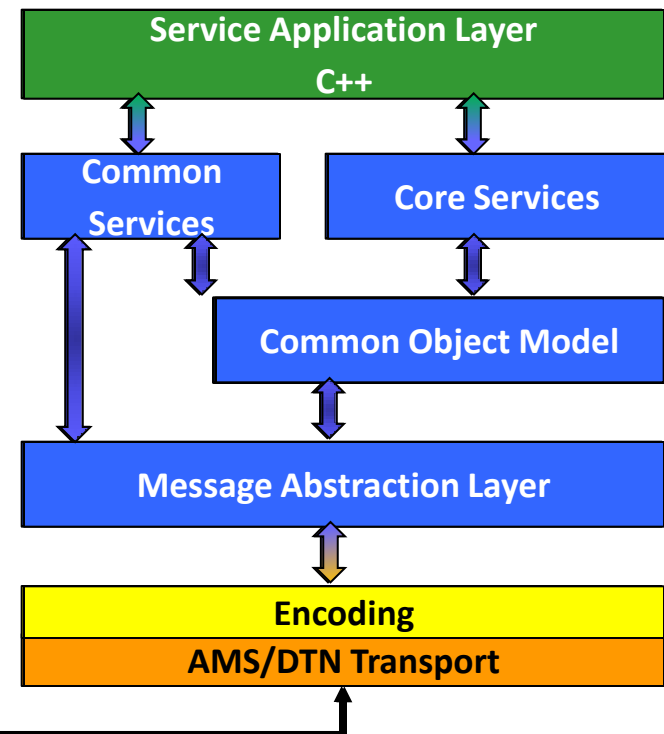
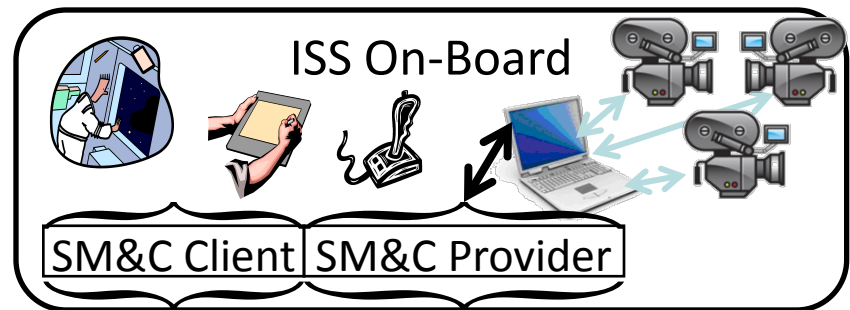
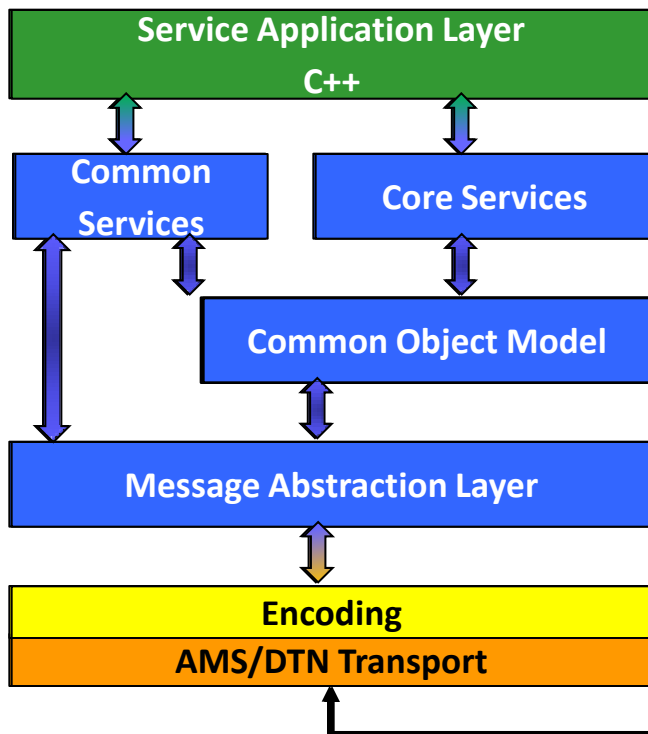
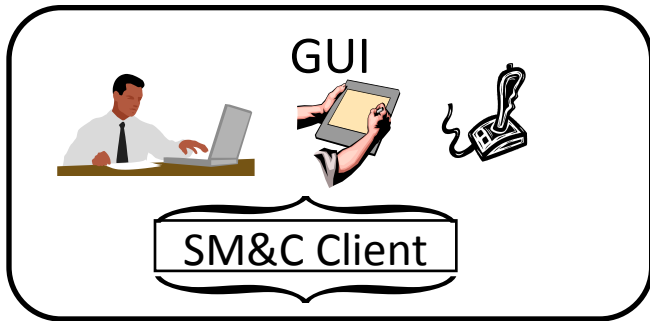
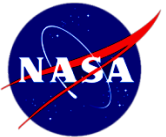


Software Architecture Baseline



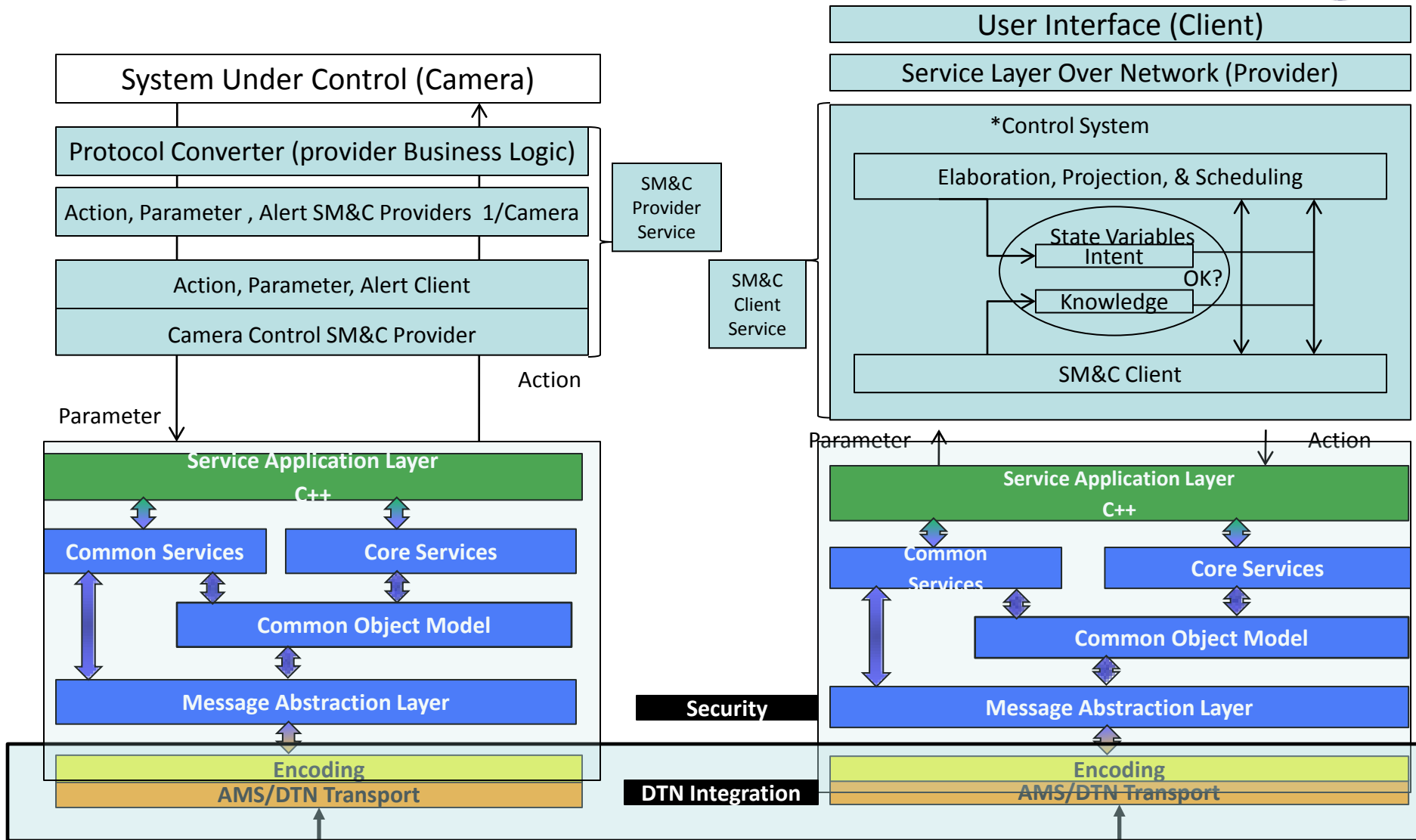
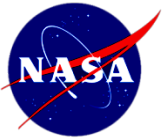


CCSDS SM&C SOA Overview



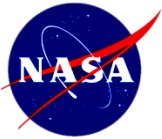


JSC State Based Camera Control Service

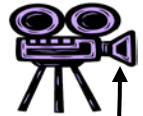




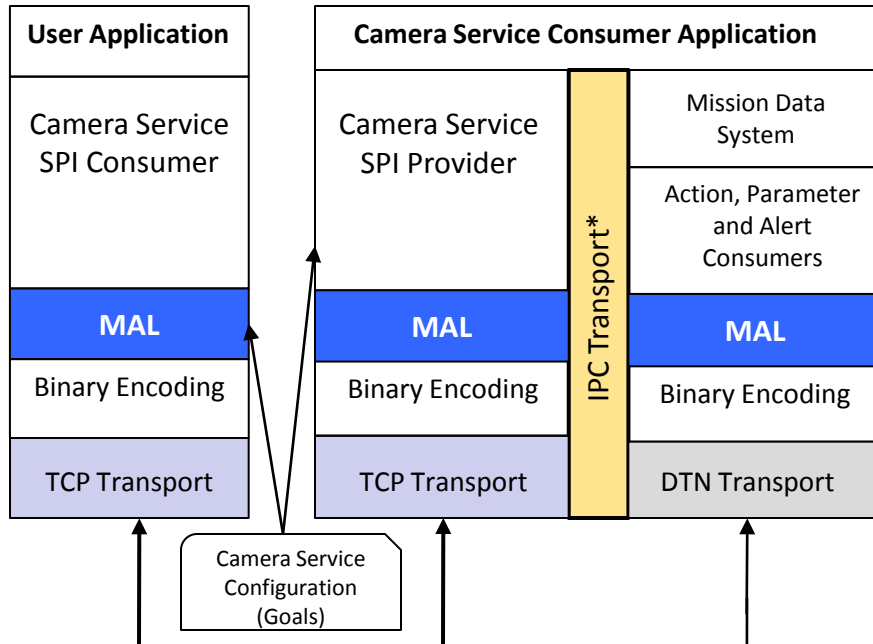
Camera Service Software Architecture



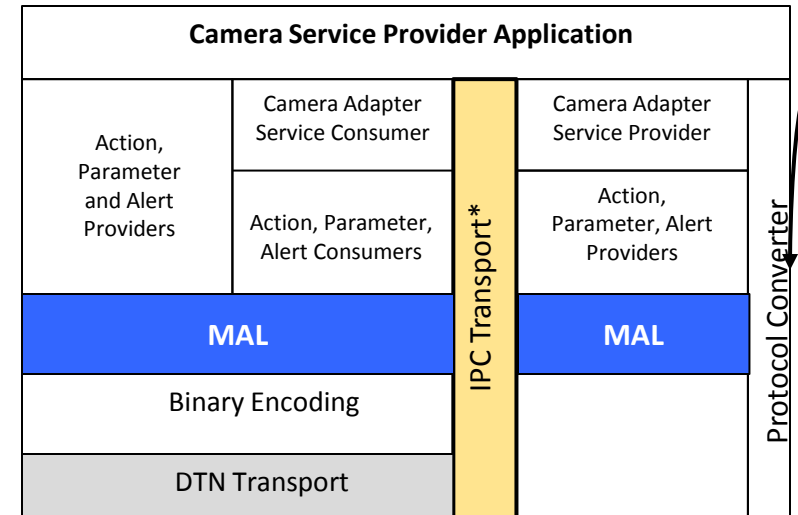
*Intra-Process Communications



Camera Service Consumer



Remote Camera Service Provider

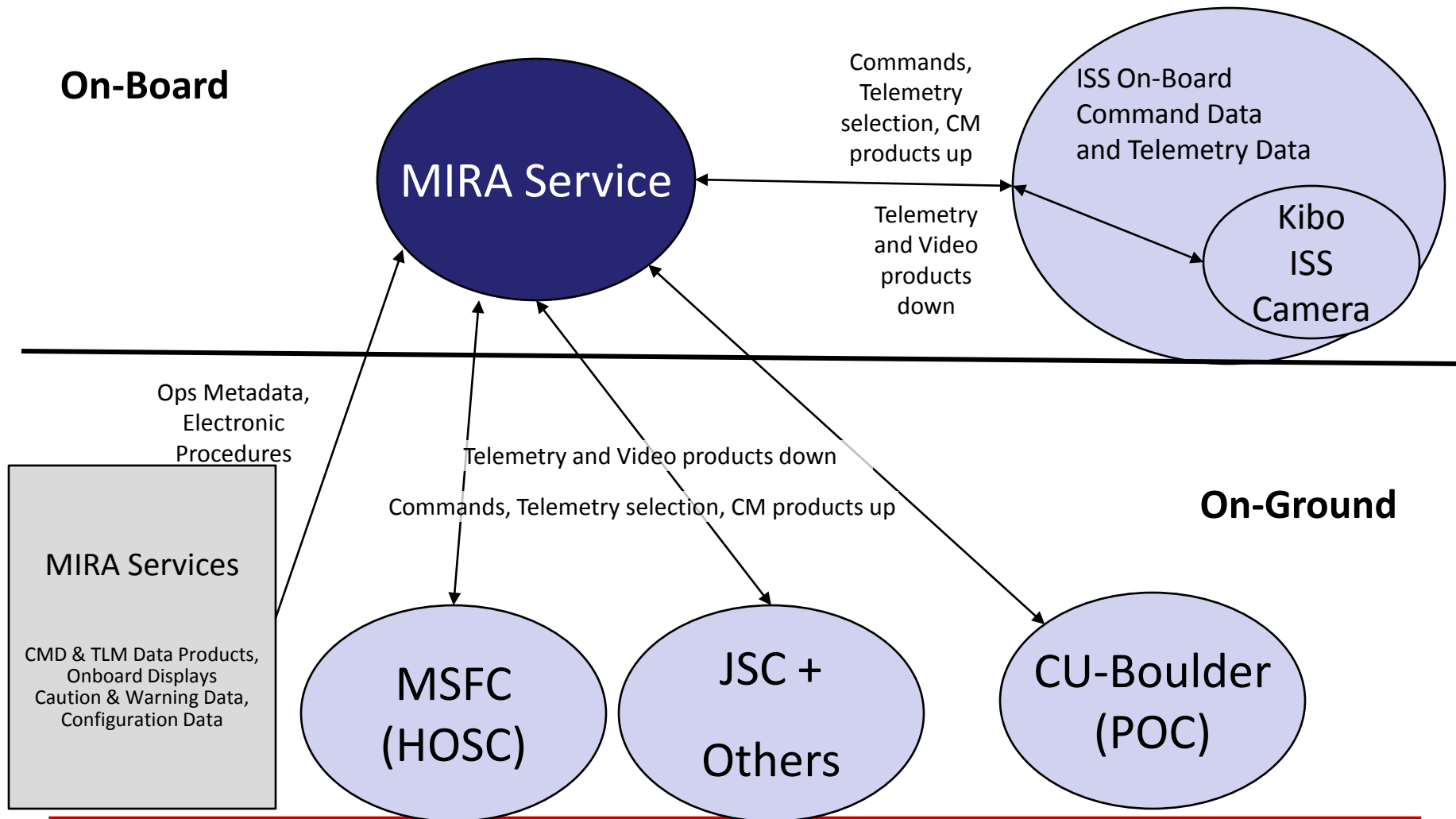




External Interfaces, Data Flows

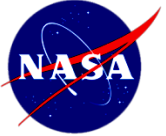


Defining external interfaces requires coordination and collaboration with the owners of “the other end of the wire”. Documentation (IRDs, ICDs, other) will be jointly developed and negotiated.

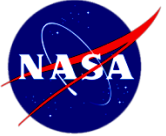




Software Areas



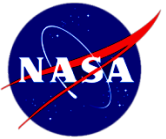
- Reuse SM&C Provider, Client, Directory Services and Broker Applications (DTN Pub/SUB)
 - Alert, Parameter, Action Services
 - MAL (re-implement the transport layers for DTN)
 - Encoding – (Reuse – binary)
 - Directory Services (Reuse)
 - Publish/Subscribe
 - Ground Client
 - Provider
- Camera adapters
- Client Apps
 - New GUI
 - n-tier, using SM&C to communicate between GUI and ground client) Give GUI developers a MAL



Development Camera Candidate



AW-HE100 PTZ Control



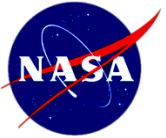
Video Out
BNC Connector
Serial Digital Interface (Video Out)

Camera Status & Control
Cat-5 Connector
RS-422





AW-HE100 PTZ Control

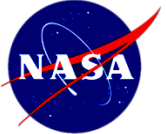


- Multiple Panasonic controllers available
 - AW-RP555/655
 - AW-RP400 + AW-CB400 + AW-IF400
- Controllable by other manufacturer control systems
- AW Series Protocol
 - Panasonic proprietary but available
 - RS-422 communications over IP *cable* (i.e. CAT 5/5e/6 w/RJ-45 connector, not IP protocol)
 - Up to 1000' from Panasonic controller to camera

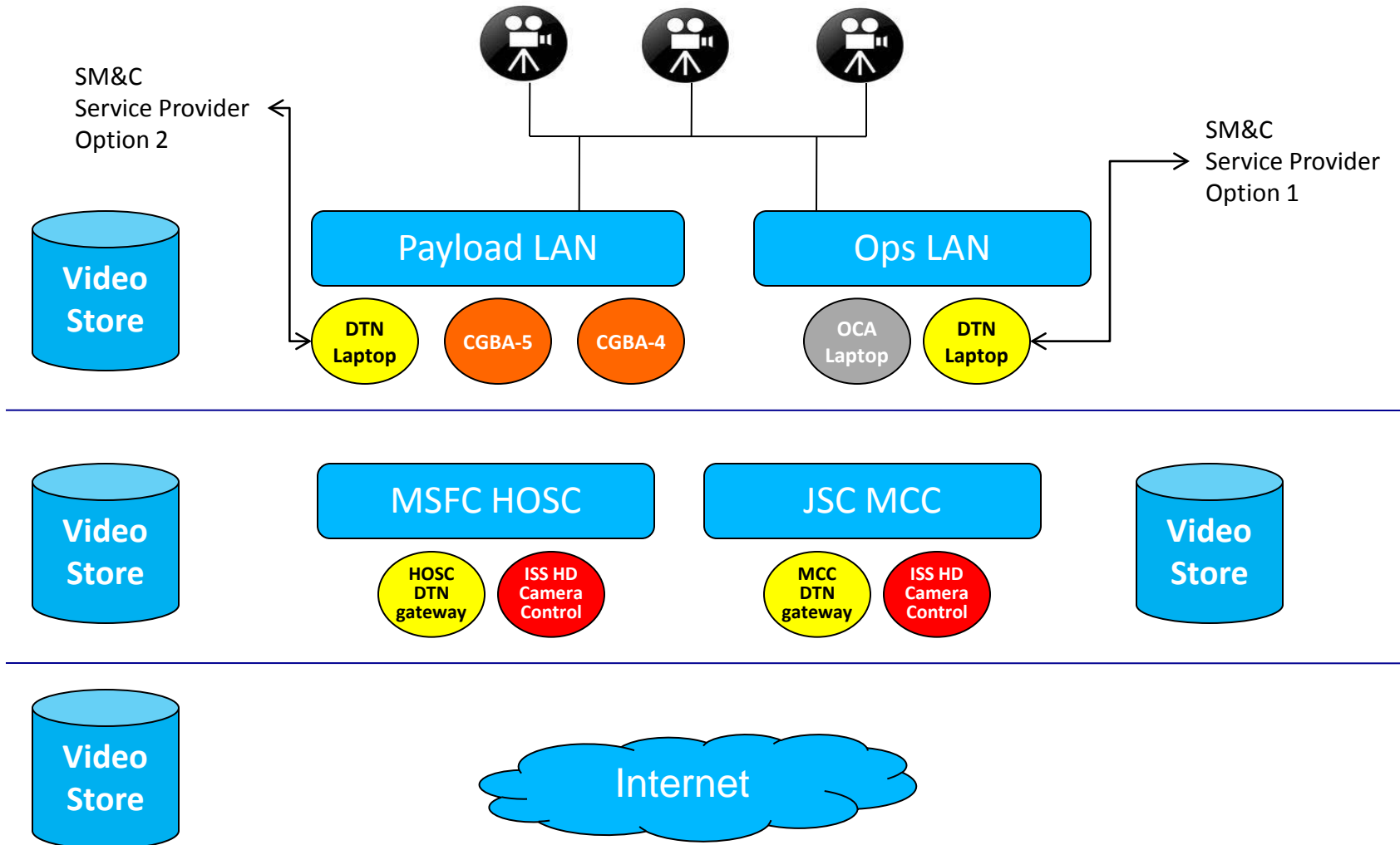
Communications



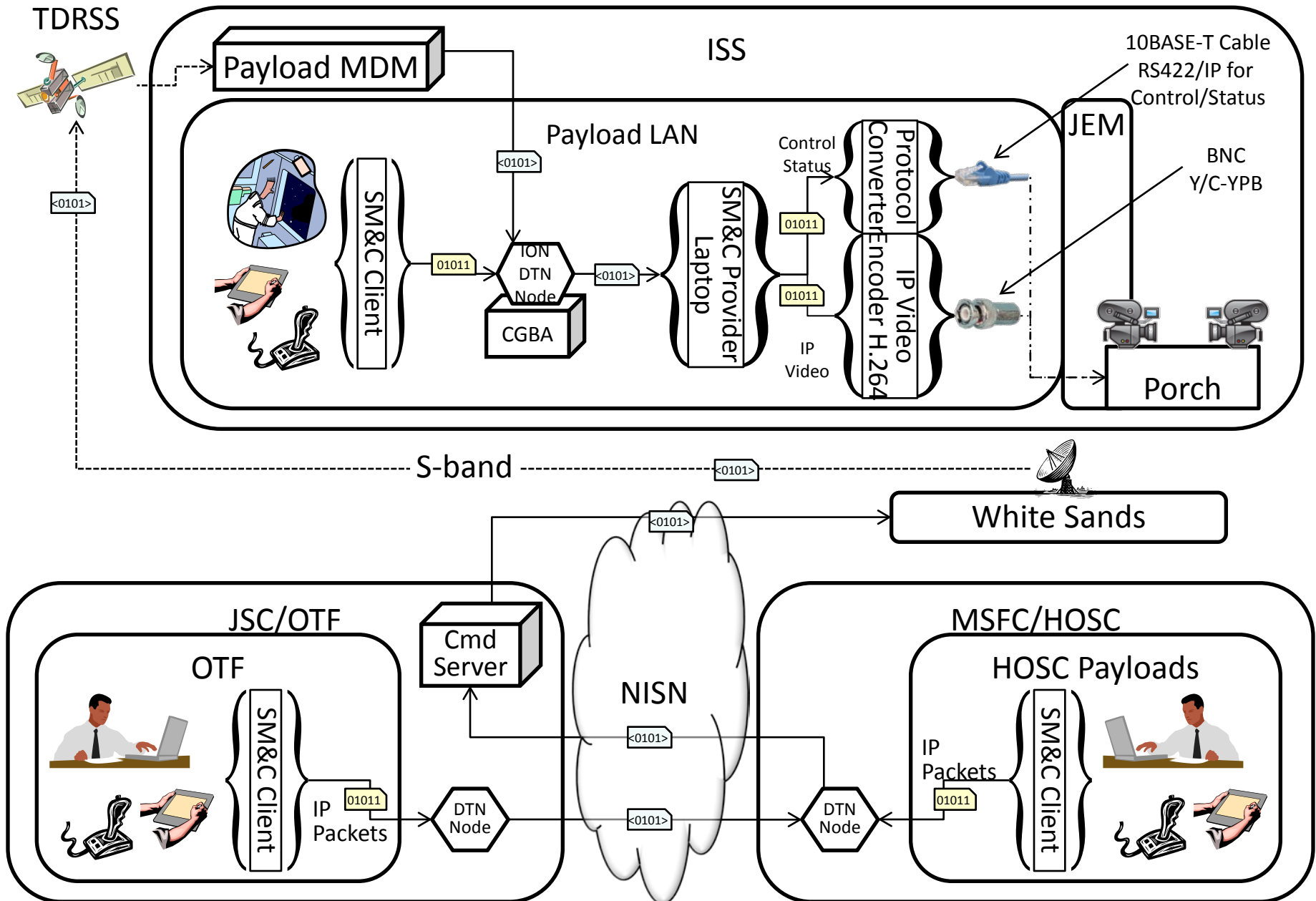
On-board Communication Trade 2



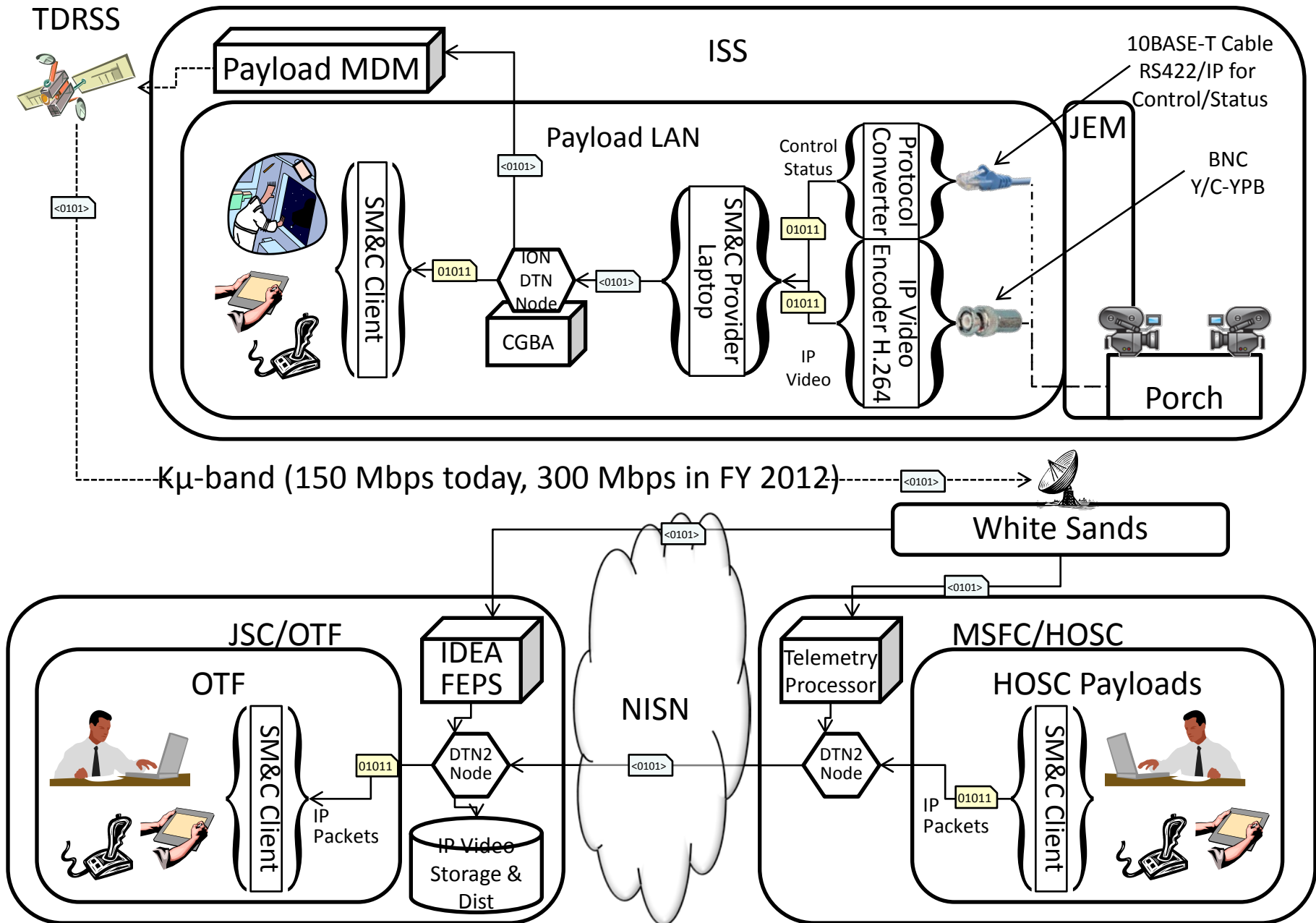
Source Kevin Gifford/CU-Boulder



Option 2: Payload Uplink Path



Options 2: Payload Downlink Path

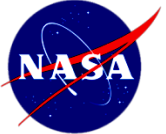


Forward Plans

10/8/2010



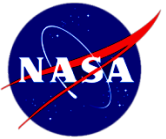
Phasing



- Phase 1 – Ground Demonstration Test
 - Monitor and Control real cameras on the ground
 - Using standards (CCSDS SM&C over DTN)
 - CCSDS Spring 2011 Berlin demo around April 30, 2011
 - Multi-center collaboration (JSC, MSFC, JPL, CU-Boulder)
- Phase 2 – ISS Communication Test
 - Round trip monitor and control of an on-board ISS camera emulator on running a laptop
 - Using standards (CCSDS SM&C over DTN)
 - Complete by 08/2011
 - CCSDS Fall 2011 meeting demo around October 30, 2011
 - Multi-center collaboration (JSC, MSFC, JPL, CU-Boulder)
- Phase 3 – Final Development and Deployment
 - Monitor and control cameras real cameras on the ISS
 - Using standards (CCSDS SM&C over DTN)
 - Cost and Date is TBD



Phase 1 Minimum Demo Requirements



- Berlin Demo Highlights
 - Connectivity to Berlin DIN
 - Berlin trough 4G connection (ATT)
- Berlin Demo minimum functionality shall include
 - Pan, tilt, zoom, focus, iris control, recall presets
 - White balance preset, scenes
 - Return status(Confirmation), limit on pan, tilt, temperature sensor
 - Supporting GUI will need to be created
- USE MCCX type secure remove access
- Use Extended Voice for ground coordination

